Eur J Vasc Endovasc Surg **28**, 442–448 (2004)
doi: 10.1016/j.ejvs.2004.06.008, available online at http://www.sciencedirect.com on SCIENCE DIRECT®

SHORT REPORT

Simultaneous Endovascular Exclusion of Thoracic Aortic Aneurysm with Open Abdominal Aortic Aneurysm Repair

J. Szmidt,[1*] O. Rowiński,[2] Z. Gałązka,[1] T. Jakimowicz,[1] S. Nazarewski,[1] T. Grochowiecki[1] and R. Pacho[2]

Departments of [1]General, Vascular and Transplant Surgery, and [2]Radiology, Medical University of Warsaw, Warsaw, Poland

Background. *The treatment of aneurysms at multiple sites within the aorta is problematic.*
Methods. *Between March 2002 and June 2003 in the Department of General, Vascular and Transplant Surgery, Medical University of Warsaw six patients with coexisting abdominal and descending thoracic aortic aneurysms underwent simultaneous open abdominal aortic aneurysm (AAA) repair and endoluminal thoracic aortic aneurysm (TAA) repair. The indication for a combined procedure was a diagnosed descending TAA and AAA with no significant risk factors for open aortic surgery or technical contraindications for endovascular treatment of TAA.*
Results. *One patient died in the peri-operative period while the other five patients all recovered well after surgery and were discharged with both aneurysms excluded.*
Conclusion. *Endovascular treatment of TAA combined with a simultaneous open AAA repair is an efficient and relatively safe treatment modality in patients with TAA and AAA disqualified from endovascular repair. The fact that thoracotomy is not a necessity significantly lowers the complication rate in these patients.*

Key Words: Multilevel aortic aneurysm; Endovascular thoracic aortic aneurysm treatment; Open abdominal aortic aneurysm surgery.

Introduction

Multilevel aortic aneurysms poses a serious problem for vascular surgeons in the terms of choice of an adequate surgical method of treatment. Open surgery is still associated with significant morbidity and mortality especially in patients with thoracic aortic aneurysms (TAA).[1–3] Ten to 29% of patients with TAA have coexisting abdominal aortic aneurysms (AAA).[2,4] Historically, multilevel aortic surgery was performed in these patients simultaneously or subsequently.[5] An alternative to open surgery could be stentgraft placement for TAA and AAA.[4] AAA morphology is not always suitable for endovascular repair (short or conical neck, severe angulations of the neck or iliac tortuosity). Additionally, in some patients a good result of open aneurysm repair can be predicted. In such cases simultaneous stentgraft placement for TAA combined with open repair for AAA may be a viable method of treatment. It allows for a lower complication risk, than for a procedure associated with open thoracotomy and high aortic cross-clamping and excludes both aneurysms from circulation.

*Corresponding author. J. Szmidt, Department of General, Vascular and Transplant Surgery, Banacha 1a, 02-097 Warszawa, Poland.

Patients and Methods

Between March 2002 and June 2003 in the Department of General, Vascular and Transplant Surgery, Medical University of Warsaw six patients with coexisting AAA and TAA underwent simultaneous open abdominal aneurysm repair and stentgraft placement through the implanted gelatin-coated Dacron abdominal vascular prosthesis side limb. This group of patients consisted of two females and four males with a mean age of 70 years, four of whom were heavy smokers. Four patients from this group suffered significant co-morbidities including hypertension (4), coronary artery disease (4), history of myocardial infarction (2), COPD (1) and diabetes (1). Two patients

1078–5884/040442 + 07 $35.00/0

had also occlusive iliac disease. Patient characteristics are shown in Table 1.

The aneurysms were detected clinically (1), or incidentally on plain X-ray (2), abdominal ultrasound (1) or echocardiography (2). In all cases contrast-enhanced thoracoabdominal spiral computed tomography (3 mm slides) were performed to measure abdominal and thoracic aneurysm diameters with evaluation for stentgraft implantation. Three dimensional reconstruction and angio-CT were performed (Fig. 1). In addition in two cases digital subtraction angiography was performed to attain a clearer morphology of the aortic arch. The indication for a combined procedure was a diagnosed descending TAA and AAA with technical contraindications for endovascular treatment or no significant risk factors for open abdominal aortic surgery (patient nos. 1 and 5). All thoracic aneurysms began below the left subclavian artery ostium. All except one abdominal aneurysm were infrarenal, with one suprarenal aneurysm involving the celiac trunk and superior mesenteric artery. Preoperative measurements are shown in Table 2.

For TAA exclusion, Talent (Medtronic) straight tube devices were used. The graft length exceeded the aneurysm length by approximately 3–4 cm and diameter oversizing was 10–15% (4–6 mm). In two patients low molecular weight heparin was administered for 5 days preoperatively. Prior to surgery, informed consent was obtained from all patients for thoracotomy. The patients were prepared and draped as for thoracoabdominal surgery. All procedures were performed in the operative theatre under general anesthesia. In all cases a transperitoneal abdominal midline approach was used. After heparinization (70 IU/kg), aortic cross-clamping was performed in the infrarenal aortic segment except in the patient with a suprarenal aneurysm. In all patients a bifurcated gelatin-coated Dacron prosthesis (Uni-graft; Braun) was used. After the upper and contralateral limb anastomosis was completed, the aorta was declamped and through the ipsilateral limb of the vascular prosthesis a Talent straight tube graft was placed under fluoroscopic guidance (Fig. 2). Final angiography revealed complete exclusion of thoracic aneurysm with no endoleak (Fig. 3). After all catheters were removed the ipsilateral limb was completed. Abdominal wall closure completed surgery and the patient was transferred to intensive care unit.

Results

In one case the AAA involving the celiac trunk,

Table 1. Patient characteristics

Patient	Age	Sex	Coronary disease present	History of MI	Hypertension	Cerebrovascular disease	COPD	Diabetes	Renal dysfunction	Obesity	Smoking	High lipid level	Occl. iliac dis.	Preoperative coagulopathy*
1	64	M	No	No	No	No	No	No	No	No	Yes	Yes	No	No
2	72	M	Yes	yes	No	No	No	No	No	No	No	No	No	No
3	77	F	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
4	73	M	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	No
5	69	F	No	No	Yes	No	No	No	No	No	Yes	Yes	No	No
6	67	M	Yes	No	Yes	No	Yes	No	No	No	Yes	No	No	Yes
Overall	70	2F/4M	4/6	2/6	4/6	1/6	1/6	1/6	0/6	2/6	4/6	4/6	2/6	2/6

MI, myocardial infarction; COPD, chronic obstructive pulmonary disease.
*If present low molecular weight heparin was administered 5 days preoperatively.

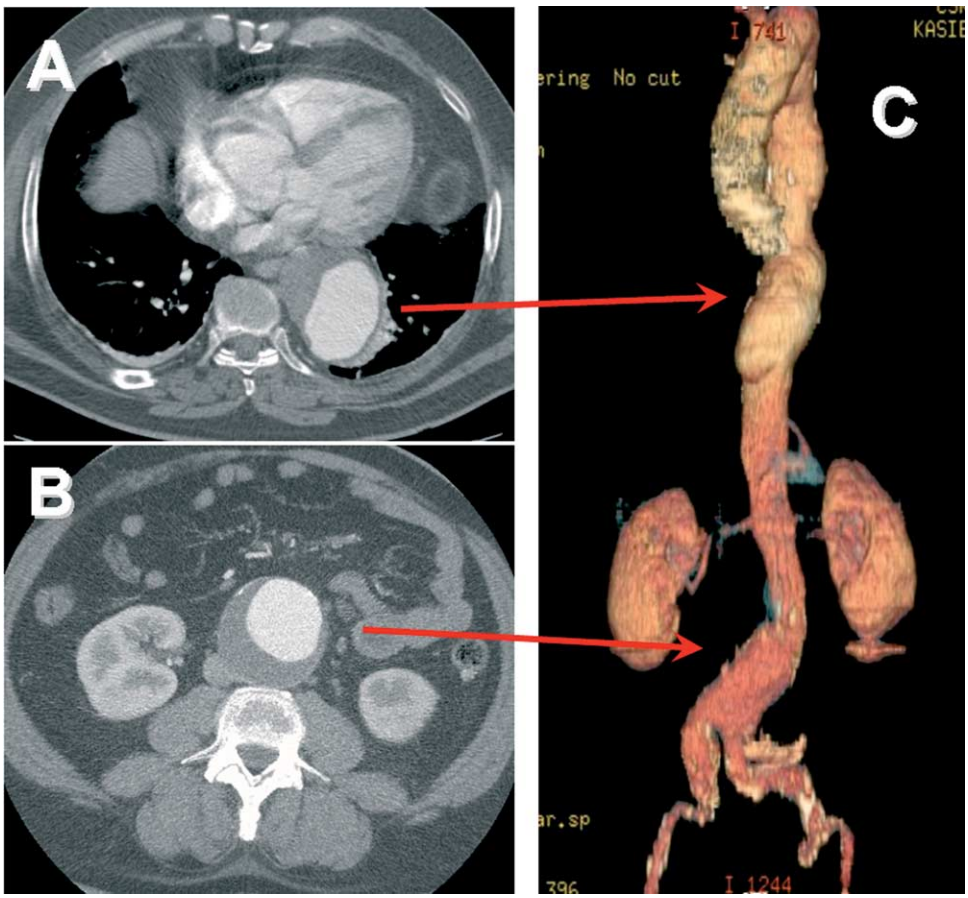

Fig. 1. CT of patient with TAA (A) and AAA (B) with 3D angio-reconstruction (C).

superior mesenteric artery and renal arteries. In this patient an intraoperative coagulopathy developed which required plasma and blood transfusion and recombinant human coagulation factor VIIa. Two hours after primary abdominal closure a relaparotomy was performed due to persistent intra-abdominal hemorrhage. Intensive management with blood transfusion, recombinant human coagulation factor VIIa and abdominal packing was ineffective and the patient died 1 h after the second operation.

In all remaining cases, after a one day ICU stay the patient returned to the Department ward. Pre-discharge CT-scan revealed complete thoracic aneurysm exclusion and no endoleak (Fig. 4). No other early postoperative complications occurred, in particular there were no cases of spinal cord ischemia. In the follow-up period (8–23 months) CT-scans were performed on the third, sixth and 12th months postoperatively. We detected one type I endoleak due to thoracic stentgraft migration in a 6 months CT scan, which was treated by implanting an additional proximal stentgraft segment. No other types of endoleak were observed. There were no migration, aneurysm expansion, and any other complications associated with thoracic stentgraft placement or abdominal aneurysmectomy. No neurological defects were observed in this follow-up time. Detailed results are shown in Table 3.

Discussion

Since the first endovascular repair of a thoracic aortic aneurysm in 1992[6] there has been a significant increase in the numbers and indications for stentgraft implantation for diseases of the descending aorta. This procedure has rapidly become a valuable alternative for thoracic aneurysm treatment.[6–9] If the patient is considered to be a candidate for endovascular treatment, careful assessment of TAA morphology should be performed. The aneurysm should not exceed the left subclavian artery proximally and there should be an adequate landing zone distally without involvement of major aortic branches. However,

Table 2. Preoperative measurements of AAA and TAA according to CT-scan

Patient	AAA								TAA			
	Diameter	Renal a. involvement	Proximal neck diameter	Proximal neck length	Proximal neck angulation	Iliac a. involvement	Significant iliac tortuosity	Feasible for endovasc repair	Diameter	Length	Proximal neck[a] diameter	Proximal neck[a] length
1	45[b]	No	24	50	Yes (60°)	Right common	No	Yes	61	97	29	135
2	65	No	21	28	No	No	Yes	No	91	104	31	42
3	51	No	24	8	Yes (90°)	No	No	No	65	210	34	16
4	74	Yes	–	–	–	No	No	No	87	64	35	137
5	69	No	24	31	No	No	No	Yes	73	53	31	142
6	71	No	22	47	Yes (80°)	Both common	No	No	59	57	32	24

All dimensions are in mm.
[a]as measured from the left subclavian artery ostium.
[b]Symptomatic AAA.

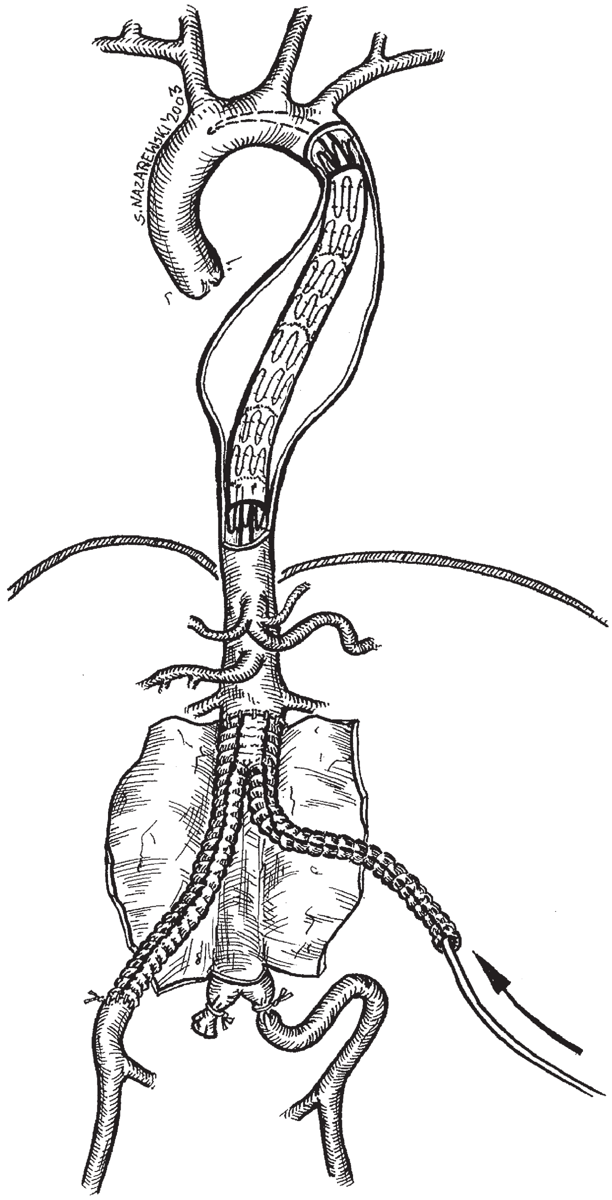

Fig. 2. Thoracic stentgraft placement through the limb of the abdominal vascular prothesis.

multifenestrated devices may allow for a more widespread use of stentgafts in aneurysms involving collateral vessels.[4]

There is a very little data available for combined thoracic and abdominal aneurysm repair. According to Moon *et al.* historically, there were several ways of surgical treatment of multilevel aortic aneurysms.[2] Simultaneous thoracic and abdominal aneurysm repair is a challenging surgical procedure, which can also be performed through separate incisions. The operation can be staged in time, and the order should be determined in accordance to aneurysm size and

Fig. 3. Final intraoperative angiography of thoracic aorta-complete exclusion of the aneurysm with no endoleak.

Fig. 4. Pre-discharge CT-scan 3D reconstruction of the aorta.

symptoms. Crawford suggested an initial repair of the thoracic aneurysm in asymptomatic patients.[10,11] On the other hand 30% of deaths after descending thoracic aneurysm repair is associated with coexisting untreated infrarenal aneurysm rupture.[12] In accordance with this data, Crawford performed simultaneous surgery in patients who continued to do well in the operating room after the first replacement. The mortality rate for such a procedure was 10%.[11] It is also possible to exclude coexisting TAA and AAA by means of thoracic and abdominal stentgrafts. This can be performed simultaneously or subsequently and is a viable alternative for high risk patients.[4] According to many authors there is no reason for endovascular AAA repair in patients without significant risk factors. In our opinion in patients with multilevel aneurysmal aortic disease the choice of treatment of the concomitant AAA should be the same as in patients with AAA only. The presence of TAA should not modify the treatment method of the AAA.

Eton reports a case of thoracic stentgraft implantation two weeks after open abdominal aneurysmectomy in a patient with a suspected mycotic thoracic aneurysm.[8] Nevertheless if there is no contraindication, both aneurysms should be excluded simultaneously. This seems a much simpler approach, with the straight tube thoracic graft inserted through the limb of the abdominal prosthesis, with no additional groin incision.

When considering patients with thoracoabdominal aneurysms it is obligatory to evaluate the patient's cardiopulmonary status. Many patients because of their poor cardiopulmonary reserve can still be considered for a combined procedure where they would be otherwise unfit for open thoracotomy. In our series at least in two patients open thoracotomy could not be performed due to poor cardiopulmonary status.

A serious problem following endovascular and open repair of thoracic aortic aneurysms is spinal cord ischemia. According to current literature the complication rates are equal in both methods of treatment. Steroids, hypothermia, cerebrospinal fluid drainage and prevention of hypertension may be offered to lower the risk of this complication. Overall, the rate of this complication has been shown to range between 0 and 21%.[3,4,13–15]

The spinal cord is predominantly supplied with

Table 3. Operative data and results

Patient	Number of thoracic stentgraft segments used	Intraoper. endoleak	Type of abdominal distal anastomosis	Duration of procedure (min)	Blood lost (ml)	Neurologic deficit	30-days results	Follow-up (months)	Complications in follow-up
1	2	No	Comm. iliac	170	800	No	Cured	23	None
2	2	No	R-comm. iliac L-ext. iliac[a]	200	1000	No	Cured	22	None
3	2	No	Ext. iliac[a]	240	700	No	Cured	19	None
4	1	No	Comm. iliac	330	5000	–	Died[b]	–	–
5	1	No	Comm. iliac	150	500	No	Cured	11	None
6	2	Yes[c]	ext. iliac[d]	180	1200	No	Cured	8	Endoleak type I in 6th month

[a]Due to severe atherosclerosis.
[b]Died during reoperation due to persistent haemorrhage.
[c]Treated by additional stentgraft segment placement.
[d]Due to aneurysmal common iliac arteries.

blood through the Adamkiewicz artery and also by thoracic intercostal arteries, which are usually thrombosed through the aneurysm. Due to this fact these branches are very rarely reimplanted during open surgery.[16] In our study all grafts were placed relatively high. Because of this placement and the short graft length there was little risk in covering the Adamkiewicz artery and therefore no need to use spinal cord protection.

In conclusion, endovascular treatment of thoracic aortic aneurysm combined with a simultaneous open abdominal aneurysmectomy is an efficient and relatively safe treatment modality in patients with TAA and AAA disqualified from endovascular repair. The fact that thoracotomy is not a necessity significantly lowers the complication rate after this procedure. However, long-term follow-up on a larger group of patients is necessary to assess the durability and effectiveness of this method of therapy.

References

1 Svensson LG, Crawford ES, Hess KR *et al.* Experience with 1509 patients undergoing thoracoabdominal aortic operations. *J Vasc Surg* 1993; **17**:357–368.

2 Moon MR, Mitchell RS, Dake MD *et al.* Simultaneous abdominal aortic replacement and thoracic stent-graft placement for multilevel aortic disease. *J Vasc Surg* 1997; **25**:332–340.

3 Ballard JL, Abou-Zamzam AM, Teruya TH. Type III and IV thoracoabdominal aortic aneurysm results of a trifurcated/two graft technique. *J Vasc Surg* 2002; **36**:211–216.

4 Meguid AA, Bove PG, Long GW *et al.* Simultaneous stent-graft repair of thoracic and infrarenal abdominal aortic aneurysms. *J Endovasc Ther* 2002; **9**(2):165–169.

5 Gloviczki P, Pairolero P, Welch T *et al.* Multiple aortic aneurysms: the results of surgical management. *J Vasc Surg* 1990; **11**:19–28.

6 Dake MD, Miller DC, Semba CP *et al.* Transluminal placement of endovascular stent-grafts for the treatment of descending thoracic aortic aneurysms. *NEJM* 1994; **331**:1729–1734.

7 Saccani S, Nicolini F, Beghi C *et al.* Thoracic aortic stents: a combined solution for complex cases. *Eur J Vasc Endovasc Surg* 2002; **24**:423–427. doi:10.1053/ejvs.2002.1687.

8 Eton D, Terramani T, Katz M. Staged thoracic and abdominal aortic aneurysm repair using stent graft technology and surgery in a patient with acute renal failure. *Ann Vasc Surg* 2000; **14**: 114–117. doi: 10.1007/S100169910021.

9 Orend KH, Scharrer-Palmer Z, Kapfer X *et al.* Endovascular treatment in diseases of the descending thoracic aorta: 6-year results of a single center. *J Vasc Surg* 2003; **37**:91–99.

10 Crawford ES, DeNatale RW. Thoracoabdominal aortic aneurysm: observations regarding the natural course of the disease. *J Vasc Surg* 1986; **3**:578–582.

11 Crawford ES. Aortic aneurysm: a multifocal disease. *Arch Surg* 1982; **117**:1393–1400.

12 Crawford ES, Walker HSJ, Saleh SA *et al.* Graft replacement of aneurysm in descending thoracic aorta: results without bypass or shunting. *Surgery* 1981; **89**:73–85.

13 Graveraux EC, Faries PL, Burks JA *et al.* Risk of spinal cord ischemia after endograft repair of thoracic aortic aneurysms. *J Vasc Surg* 2001; **34**:997–1003.

14 Azizzadeh A, Huynh TT, Miller CC *et al.* Postoperative risk factors for delayed neurologic deficit after thoracic and thor-

acoabdominal aortic aneurysm repair: a case-control study. *J Vasc Surg* 2003; **37**:750–754.
15 Kuniyoshi Y, Koja K, Miyagi K *et al.* Prevention of postoperative paraplegia during thoracoabdominal aortic surgery. *Ann Thorac Surg* 2003; **2003**(76):1477–1484. doi: 10.1016/S0003-4975(03)00871-3.
16 Jacobs MJ, de Moll BA, Elenbaas T *et al.* Spinal cord blood supply in patients with thoracoabdominal aortic aneurysms. *J Vasc Surg* 2004; **35**(30):37. doi: 10.1067/mva.2002.120041.

Accepted 7 June 2004

Available online 29 July 2004